



PRINCETON APPLIED RESEARCH CORPORATION, BOX 565, PRINCETON, NEW JERSEY 08540

# Precision Instruments for Research





**NEW**

# Boxcar Integrator



## RECOVERS COMPLETE OR INCREMENTAL PORTIONS OF REPETITIVE WAVEFORMS FROM NOISE

The Model CW-1 Boxcar Integrator is a gated signal averaging device useful in such widely varied applications as pulsed nuclear magnetic resonance, laser excitation decay, and biological evoked response experiments.

The input to the Boxcar Integrator is sampled by a variable width, variable delay gate which can be fixed at any point on, or slowly scanned across, the repetitive waveform. The sampled portion of the waveform is averaged by a variable time constant integrator. The output of the integrator will asymptotically approach the average value of that portion

of the waveform being sampled at any moment. Because random noise averages to zero, the noise accompanying the input will be correspondingly suppressed.

Three outputs are provided by the Boxcar Integrator: a  $\frac{1}{2}\%$  panel meter display,  $\pm 10$  volts at an impedance of 1 K, and a recorder output suitable for most galvanometric and servo recorders.

### SPECIFICATIONS IN BRIEF

**Time Base Widths:** 10 microseconds to 1 second in 1, 2, 5 sequence.

**Gate Pulse Width:** Continuously adjustable from 1 microsecond to 0.11 second.

**Delay:** (a) Manual adjustment from 0% to 100% of Time Base Width.

(b) Automatic scanning from 0% to that % of Time Base Width selected by setting the Manual Delay Dial.

**Automatic Delay Scan Periods:** 1, 2, 5, 10, 20, 50 and 100 minutes.

**Price:** \$1950

**NEW**

# Waveform Eductor



## EXTRACTS REPETITIVE WAVEFORMS OR TRANSIENTS FROM NOISE

The Model TDH-9 Waveform Eductor is an analog averaging instrument which extracts experimental information in the form of repetitive waveforms or transients from background noise. It has the advantages of higher speed, greater efficiency and much lower price over comparable instruments which employ digital averaging techniques.

Waveforms are extracted by obtaining the cross-correlation function of the waveform-plus-noise with a train of delta-functions having the same repetition rate. This is done by

dividing the waveform into 100 segments. These are switched sequentially and synchronously through a resistor to 100 memory capacitors where an average is obtained and stored. The cross-correlation function will be the waveform of interest, noise having averaged to zero.

The information in the memory bank is continuously observable on a monitor scope and the average can finally be photographed or read out on an X-Y or strip chart recorder. Output smoothing provides a continuous output waveform.

### SPECIFICATIONS IN BRIEF

**Sweep Duration:** Continuously adjustable from 100  $\mu$ S to 11 Sec in five ranges. (Dwell time/channel: 1  $\mu$ S to 110 mS.)

**Characteristic Time Constants** (that time constant with which the output waveform responds to changes in the input waveform): 5 Sec to 100 Sec in 1-2-5 sequence.

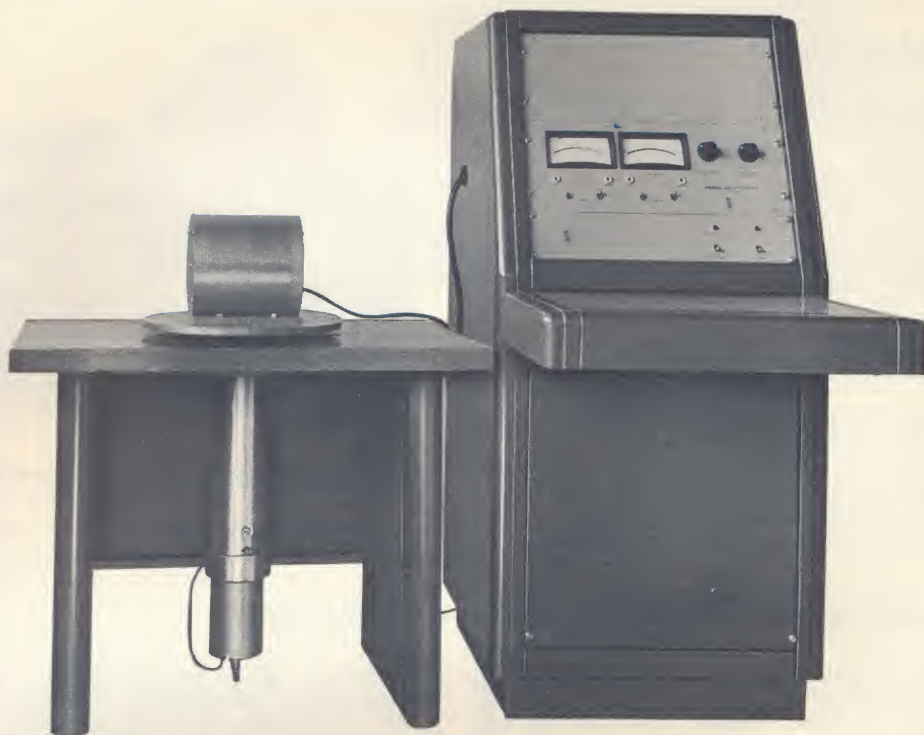
**Sweep Delay:** A delay of up to 11 Sec can be inserted between receipt of trigger pulse and initiation of sweep.

**Price:** \$4200



If you want more detailed information on any PAR instruments, please return one of the attached reply cards.

S



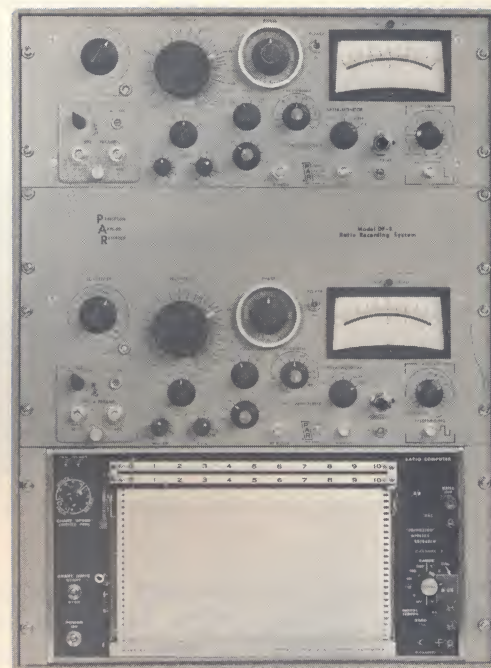
sample in a particular orientation.

Because no tuning adjustments are required, the Model SM-1 is convenient to operate and yields results that are reproducible. It provides 15 full scale ranges calibrated in terms of TOTAL MOMENT in emu from  $0.5 \times 10^{-6}$  to  $1 \times 10^{-3}$ . The system is factory calibrated to an accuracy of within  $0.5^\circ$  phase and within

1% magnitude. Sample size is a cylinder 2.49 cm in diameter and 2.28 cm in length. Slightly larger or smaller samples can be accommodated.

**Price:** \$8000 (The Model SM-1 is also available with automatic digital readout to monitor alternately the two components of the magnetic moment. Price: \$9750.)

## ing System



### SIGNALS FROM NOISE

Force and luminescence, as well as characteristic response curves, can be readily accommodated by the system. Additional flexibility is inherent in the system, since either one or both of the precision Model HR-8 Lock-In Amplifiers, as well as the recorder, can be used independently in a wide variety of experimental situations.

#### SPECIFICATIONS IN BRIEF

**Ratio Range:**  $\frac{A}{B}$  : 0.0 to 1.0, B range 0.1 to 10 V.

**Accuracy:** 0.25 per cent full scale.

**Output:** 0 — 1 V DC output proportional to recorded ratio of 0.0 — 1.0 is available to drive digital voltmeters or other external circuitry.

**Price:** \$7500



**NEW**

## Spinner Magnetometer

### MEASURES REMANENT MAGNETIC MOMENTS IN ROCK SAMPLES

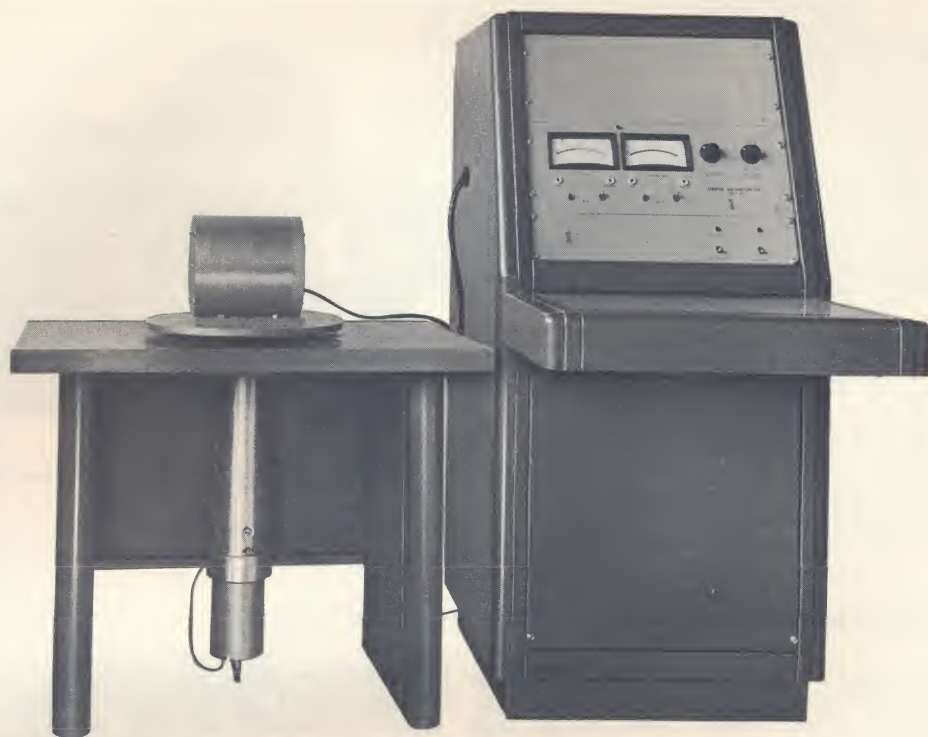
The first commercially available instrument of its kind, the SM-1 Spinner Magnetometer is valuable in geological research applications and in magnetic evaluations of samples procured during mineral and petroleum explorations. It indicates the amplitudes of two orthogonal components of the magnetic moment vector generated by spinning a rock

sample in a particular orientation.

Because no tuning adjustments are required, the Model SM-1 is convenient to operate and yields results that are reproducible. It provides 15 full scale ranges calibrated in terms of TOTAL MOMENT in emu from  $0.5 \times 10^{-6}$  to  $50 \times 10^{-3}$ . The system is factory calibrated to an accuracy of within  $0.5^\circ$  phase and within

1% magnitude. Sample size is a cylinder 2.49 cm in diameter and 2.28 cm in length. Slightly larger or smaller samples can be accommodated.

**Price:** \$8000 (The Model SM-1 is also available with automatic digital readout to monitor alternately the two components of the magnetic moment. Price: \$9750.)



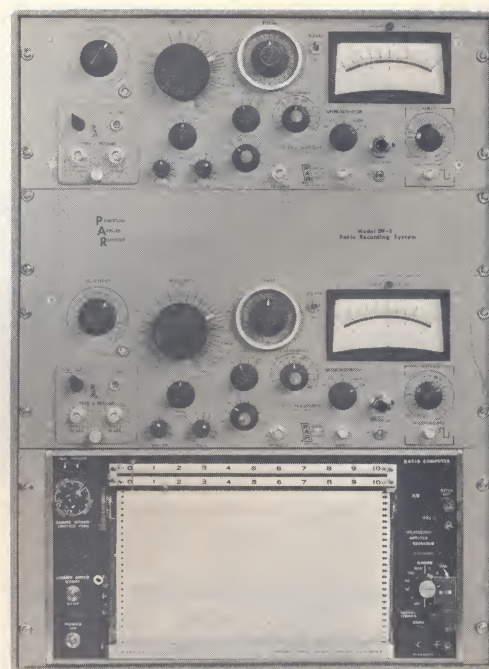
**NEW**

## Ratio Recording System

### RECOVERS TWO EXTREMELY LOW-LEVEL SIGNALS FROM NOISE AND MONITORS THEIR RATIO

The Model DF-8 Ratio Recording System combines two precision Model HR-8 Lock-In Amplifiers and a high-quality, dual channel recorder into an integrated system capable of recovering two extremely low-level signals from noise and monitoring their ratio. Relative measurements of such characteristics as transmission, absorption, reflectivity, fluores-

cence and luminescence, as well as characteristic response curves, can be readily accommodated by the system. Additional flexibility is inherent in the system, since either one or both of the precision Model HR-8 Lock-In Amplifiers, as well as the recorder, can be used independently in a wide variety of experimental situations.



#### SPECIFICATIONS IN BRIEF

**Ratio Range:**  $\frac{A}{B}$  : 0.0 to 1.0, B range 0.1 to 10 V.

**Accuracy:** 0.25 per cent full scale.

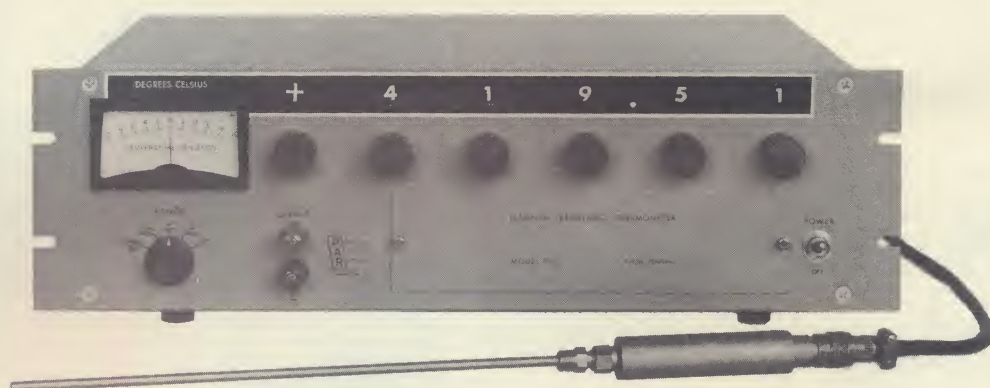
**Output:** 0 — 1 V DC output proportional to recorded ratio of 0.0 — 1.0 is available to drive digital voltmeters or other external circuitry.

**Price:** \$7500



# NEW

## Platinum Resistance Thermometer/ Temperature Controller



### 0.001°C TEMPERATURE CONTROL FROM -192°C TO +1000°C

The Model PT-2 Platinum Resistance Thermometer/Temperature Controller simultaneously measures, provides direct readout and controls temperature over a range of -192°C to +1000°C with an absolute accuracy and resolution unavailable in other instruments of this type.

It basically consists of a manually operated analog computer which solves the quadratic equation for the temperature-versus-resistance relationship for platinum (the material whose

characteristics define the International Temperature Scale.) The resistance of a platinum sensor is converted into a **direct reading** of temperature by manually balancing a modified Kelvin Bridge. This is accomplished by means of five decade dials and a temperature deviation meter on the front panel. In its most sensitive range, the meter reads 0.01°C full scale which results in a resolution of better than  $\pm 0.0005^\circ\text{C}$ . Absolute accuracy\* of the instrument is  $\pm 0.01^\circ\text{C}$  from  $0^\circ\text{C}$  to  $+1000^\circ\text{C}$  and  $\pm 0.1^\circ\text{C}$  from  $-192^\circ\text{C}$  to  $0^\circ\text{C}$ .

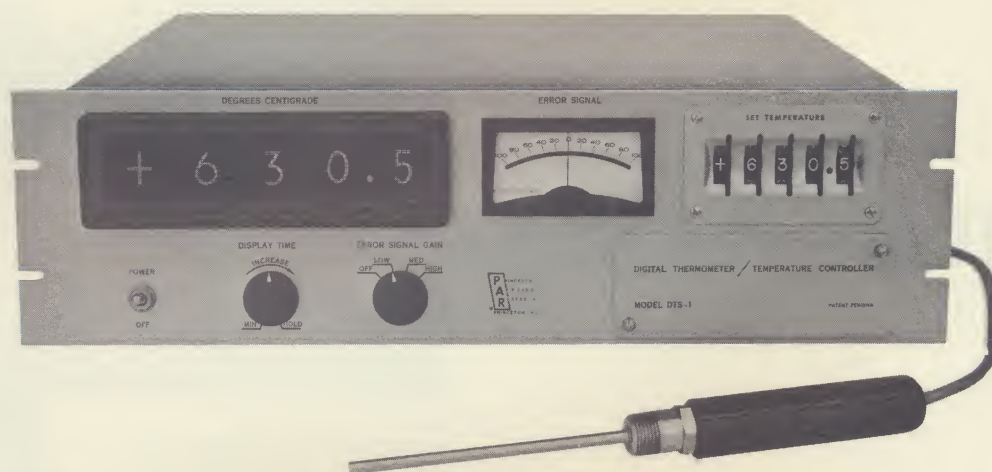
For temperature control, a signal proportional to the difference between the temperature set on the dials and the actual sensed temperature is continuously available. This signal may also be used to obtain expanded scale measurements, recording, or high/low alarm. Multipoint sensors can be monitored by a scanner.

**Price:** \$2650 (excluding probe)

\*Subject to operating range of actual sensor used.

# NEW

## Digital Thermometer/ Temperature Controller



### FULLY AUTOMATIC TEMPERATURE INDICATION AND CONTROL FROM -192°C TO +1000°C WITH 0.1°C ACCURACY\*

The Model DTS-1 offers a new order of reliability, convenience and accuracy in laboratory and process control thermometry. The unit operates by comparing the resistance of a sensor element of platinum (the material whose characteristics determine the International Temperature Scale) with an internally generated reference function that precisely duplicates the temperature-versus-resistance

change of platinum. This method allows an absolute accuracy of  $0.1^\circ\text{C}$  to be achieved. A modified Kelvin Bridge eliminates sensor lead resistance errors, permitting precise remote temperature monitoring.

In addition to direct visual readout, measured temperature information is available in binary coded or 10-line decimal form for printer or computer input as well as in pulse

code modulated form for telemetry applications. For temperature control or strip-chart recording, an analog signal is provided which is proportional to the difference between the measured temperature and the desired temperature selected by front panel thumbwheel switches.

**Price:** \$3950 (excluding probe)

\*Subject to operating range of actual sensor used.



# Lock-In Amplifiers

## MEASURE SIGNALS IN THE PRESENCE OF NOISE BY CROSS-CORRELATION

PAR Lock-In Amplifiers employ the theoretically optimum technique for recovering low-level signals in the presence of noise. They can be incorporated into a large class of experiments in which the signal of interest is, or can be made, periodic and in which a reference voltage related in frequency and phase to the signal can be obtained.

The Model HR-8 first amplifies and bandwidth limits the input signal and then cross-correlates it with the reference signal, suitably phase shifted and shaped. The cross-correlation of the input and reference signals yields a DC output voltage proportional to the signal of interest, while the cross-correlation of the reference and noise results in no net DC voltage. The system can also be described as a continuously integrating, highly sensitive, phase conscious voltmeter, the response of which is "locked" to that particular frequency

and phase at which the signal information has been made to appear.

### SPECIFICATIONS IN BRIEF (Model HR-8)

**Frequency Range:** 1.5 cps to 150 KC continuously tunable in 5 ranges.

**Time Constants:** 11 values in 1-3-10 sequence extending from 0.001 to 100 seconds. Single or double section RC filtering.

**Pre-Amplifiers:** Interchangeable low-noise pre-amplifiers, operable either within the HR-8 or remotely, are used.

Type A: Differential 10 megohm input.

Type B: Low impedance transformer input for low source impedances and low frequency (Type B-1 for high frequency).

Type C: Differential 50K ohm input.

**Sensitivity:** 21 calibrated full scale ranges in 1-2-5 sequence.

With Type A Pre-Amplifier: 100 nanovolts to 500 millivolts rms.

With Type B Pre-Amplifier: 1 nanovolt to 5 millivolts rms.

With Type C Pre-Amplifier: 10 nanovolts to 50 millivolts rms.

**Output:**  $\pm 10$  volts full scale, single-ended with respect to ground. Will drive galvanometric and servo recorders.

**Price:** \$1950—Main Frame.

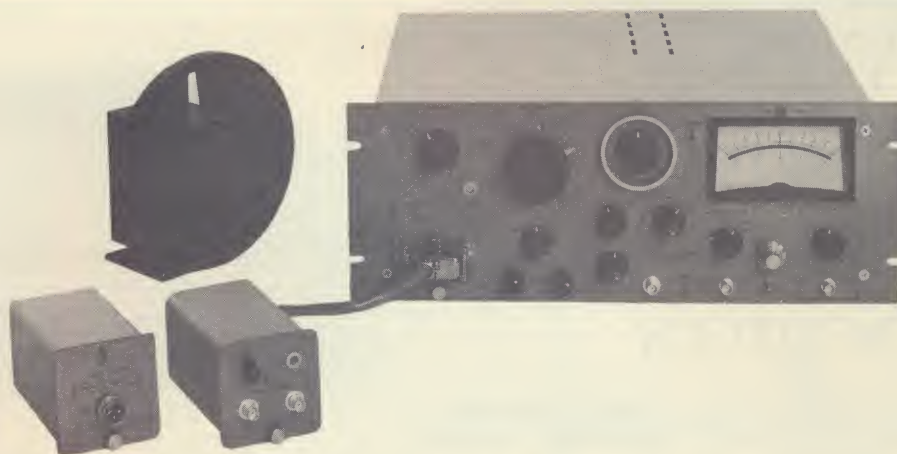
\$ 300—Type A pre-amp.

\$ 300—Type B pre-amp.

\$ 350—Type B-1 pre-amp.

\$ 400—Type C pre-amp.

Also available: Mechanical light chopper, Model BZ-1, price \$395.



# Two-Phase Lock-In Amplifier

## SIMULTANEOUSLY RECOVERS IN-PHASE AND QUADRATURE SIGNALS FROM NOISE

The Model JB-6 Two-Phase Lock-In Amplifier permits simultaneous measurement of both the in-phase and quadrature components of extremely weak signals buried in noise. This instrument operates essentially as an extremely narrow-band detector, the center frequency of which is "locked" to a particular frequency at which the signal information has been made to appear. As a result, complete freedom from drift between the detector cen-

ter frequency and the characteristic signal frequency is obtained regardless of how narrow the detection bandwidth is made. The JB-6 provides, for each phase component, individual outputs for strip chart recording, independent filtering selection and separate meter displays. An internal signal is also provided for convenient adjustments of orthogonality between channels over the entire operating frequency range.

### SPECIFICATIONS IN BRIEF

**Frequency Range:** 1.5 cps to 150 KC continuously tunable in 5 ranges.

**Time Constants:** 0, 0.001, 0.01, 0.1, 1, 3, 10 seconds and EXT. for each channel. Single and double section RC filtering.

**Gain:** (rms AC in to push-pull DC out) Greater than 9000. "In-Phase Mixer Gain" control permits making the gain of the two channels identical.

**Price:** \$1750



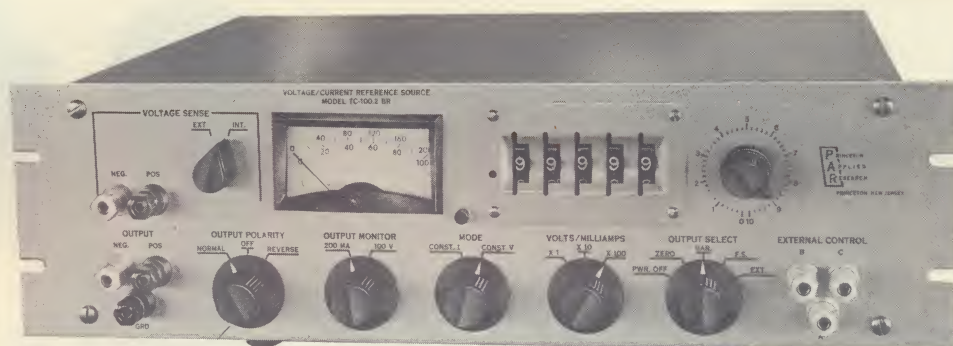


# Voltage/ Current Reference Sources

**EXTREMELY STABLE POWER SUPPLIES  
WITH ACCURACIES TRACEABLE TO N.B.S.**

All models in PAR's line of Voltage/Current Reference Sources are completely solid state and feature a careful, conservative design leading to highly reliable operation. Indicative of the features found in these units is a unique chopper-stabilized amplifier with a DC open-loop gain of  $5 \times 10^6$ , falling off no faster than 6 db/octave to unity gain. This insures extremely low output impedance (less than 10 micro-ohms at DC) and fast transient response without ringing.

PAR Reference Sources permit considerable operational flexibility, with applications ranging from the reference voltage source in analog computers to the constant current source required in "bucking" coils in elaborate magnetometer systems. All units feature digital output selectors, complete short circuit protection, and low ripple and noise.



**INDEX OF PAR REFERENCE SOURCES**

MODEL NO.	OUTPUTS		ACCURACY		RESOLUTION		100 HOUR STABILITY		PRICE
	CONST. V.	CONST. I.	CONST. V.	CONST. I.	CONST. V.	CONST. I.	CONST. V.	CONST. I.	
TC-260R	0 to 60 V @ 2 A max.	0 to 2 A @ 60 V max. (Requires Ext. Resistors)	0.01%	0.01% ± Accuracy of Ext. Resistors	1 μV	Determined by Ext. Resistors	.001%	.001% ± stability of external resistors	\$1,250.
TC-100.2R	0 to 100 V @ 200 mA max.	0 to 100 mA* @ 100 V max.	0.01% of F. S.	0.02% of F. S.	1 mV	1 μA	.001%	.002%	\$1,500.
TC-602CR	0 to 6 V 0 to 60 V @ 2 A max.	0 to 60 mA 0 to 600 mA 0 to 2 A @ 60 V max.	0.01% of F. S.	0.03% of F. S.	1 μV min.	10 nA min.	.001%	.002%	\$1,750.
TC-100.2AR	0 to 100 V 0 to 10 V 0 to 1 V @ 200 mA max.	0 to 100 mA* 0 to 10 mA 0 to 1 mA @ 100 V max.	0.01%	0.02%	10 μV min.	10 nA min.	.001%	.002%	\$1,800.
TC-100.2BR	0 to 100 V 0 to 10 V 0 to 1 V @ 200 mA max.	0 to 100 mA* 0 to 10 mA 0 to 1 mA @ 100 V max.	0.01%	0.02%	100 nV min.	100 pA min.	.001%	.001%	\$2,200.
SF-Series (Fixed)	Any fixed voltage to 100 V @ 2 amps max.	Any fixed current to 2 amps @ 100 V max.	Within setting resolution		Up to 1 ppm of adjustable range about nominal		.001%	.001%	By quotation only.

\*Available to 200 mA (at extra charge).

# Potentiometric Measuring System



**MEASURES EXTERNAL RESISTANCE RATIOS  
OR DC VOLTAGES TO ONE PART PER MILLION**

The Model PPMS-1 comprises the basic components required for making one part per million measurements of external resistance ratios or external DC voltages to 1000 volts. The system, with accuracy traceable to N.B.S., consists basically of a 10 volt DC source whose saturated standard cell reference is housed in a proportional temperature controlled oven (maintained within 0.001°C), a self-calibrating 7 decade Kelvin-Varley divider

and a null indicator having a basic full scale sensitivity of  $\pm 1$  microvolt.

An output signal fully isolated from, but proportional to, the deflection of the null meter is provided by the Model PPMS-1 to drive strip-chart recorders and thereby function as a self-contained monitor of the stability of other voltage supplies. In addition, it can serve as the controlling element in ultra-stable variable voltage or current supplies

with the addition of accessory power amplifiers.

The unit contains a unique method of self-calibrating the four most significant decades of the Kelvin-Varley divider. It also features a means of verifying oven temperature and standard cell voltage without the use of additional equipment.

**Price: \$4950**



## Return this card for more information

Have a PAR field engineer call ☐

- Boxcar Integrator, Model CW-1 ☐
- Digital Voltmeter, Model CS-3.1 ☐
- Digital Thermometers/Temperature  
Controllers, Models DTS-1 & PT-2 ☐
- Lock-In Amplifiers, Model HR-8 & JB-Series ☐
- Low-Noise Amplifier, Model CR-4/CR-4A/AM-1 ☐
- Microwave Interferometers, MIPD-Series ☐
- Potentiometric Measuring System, Model PPMS-1 ☐
- Reference Sources, TC-Series ☐
- Spinner Magnetometer, Model SM-1 ☐
- Vibrating Sample Magnetometer, Model FM-1 ☐
- Waveform Eductor, Model TDH-9 ☐

Name

Title

Company

Address

City  State  ZIP

Telephone (area code)

Mailing list: continue ☐ remove ☐ add these names:

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- Waveform Eductor, Model TDH-9 ☐

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Telephone (area code)

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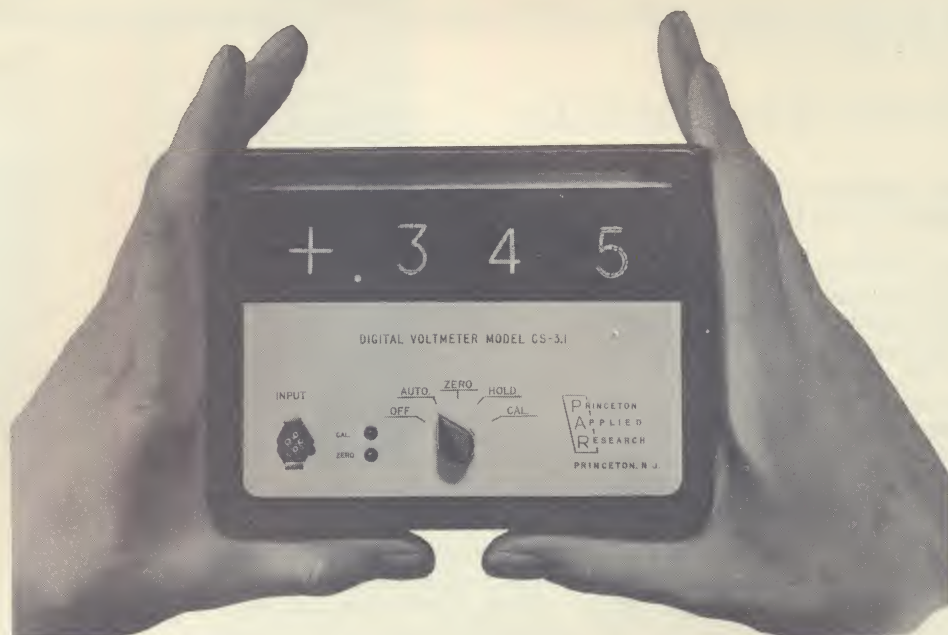
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# Digital Voltmeter



**ONLY 6½" WIDE BY 5" HIGH,  
WEIGHS 9 LBS.**

The Model CS-3.1 represents a breakthrough in reducing the size of digital voltmeters. Only 6½" wide by 5" high and 8¾" deep, it weighs 9 lbs. Both automatic polarity indication and automatic ranging are provided. Balancing time is from 0.15 to 3.15 seconds, depending on the range change required. Sensitivity is 1 millivolt. Accuracy is  $\pm 0.1\%$  of reading  $\pm 1$  count.

A floating and guarded differential input

circuit permits differential voltage measurements with guard floating up to  $\pm 500$  volts DC with respect to chassis, which is at power line ground. Common mode rejection is greater than 100db. Input impedance is a minimum of 10 megohms at all times. The Model CS-3.1 is available with 10-line decimal coded output for digital printout. It may be used with an associated remote readout.

Circuitry is completely solid state except for

two miniature nuvistor tubes at the input stage of the comparator to obtain high impedance input. High reliability dry-reed relays are used to switch the attenuators for automatic ranging, automatic polarity, and amplifier stabilization. Long service-free life is assured by the use of glass epoxy boards, aged zener references, rugged plug-in printed circuit construction, and long-life nixie tubes.

**Price: \$995**

# Low-Noise High-Gain Amplifier



## FOR EXTREMELY SMALL SIGNAL PRE-AMPLIFIER APPLICATIONS

The Model CR-4 Low-Noise High-Gain Amplifier is designed for extremely small signal pre-amplifier applications and for use with the PAR JB-Series of Lock-In Amplifiers to extend their low-level signal recovery capabilities. The unit features:

- differential or single-ended input
- high (50M) or low (50K) input impedance

- selectable by front panel switch
- 20 to 80 db gain
- selectable bandpass 1 cps to 300 KC
- long-life mercury or rechargeable NiCd battery pack
- completely transistorized
- rugged printed circuit construction

- 6½" wide, 5" high, 8¾" deep
- easily panel mounted
- price without batteries: \$575
- also available: several optional features such as impedance matching input transformer and fast-recovery Model CR-4A with selectable bandpass from 10 cps to 300 KC.



# Microwave Interferometers

## FOR DETERMINING ELECTRON DENSITIES IN PLASMA

The MIPD-Series of Microwave Interferometers are "zebra stripe" type display instruments having potential uses for plasma studies in the fields of arc and flame studies, high temperature shock phenomena, missile wake and re-entry investigations, thermonuclear fusion, direct hydro-magnetic power production and basic plasma research.

They are essentially swept-frequency dispersive bridges, self-calibrating and self-zeroing, so that in making a measurement, only the relative fringe shifts must be determined. Significant features of this type of a display scheme are:

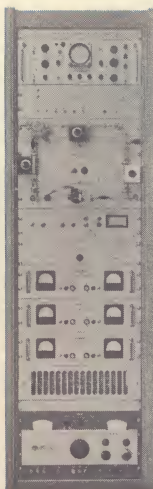
- Fringe pattern deflection is directly proportional to phase shift (which, in turn, is a function of electron density).
- Direct and continuous calibration, in terms of interfringe spacing.

tion, in terms of interfringe spacing.

- Continuous fringe display permits wide dynamic range for phase shift measurements.
- Capability of resolving fast transient phase shifts.

Units are completely self-contained in a relay rack and are supplied with 32 feet of waveguide for use in the long path of the bridge. They are available in discrete frequencies up to 140 KMC (2mm).

**Price:** (by quotation only): 4mm system \$22,500.

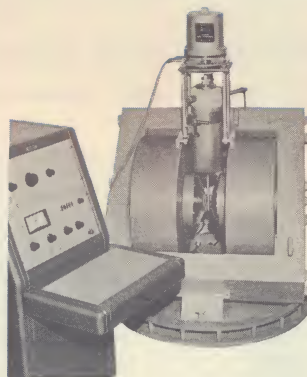


# Vibrating Sample Magnetometer

## FOR MEASURING MAGNETIC MOMENTS OF SOLIDS, LIQUIDS AND GASES

The FM-1 Foner\* type Vibrating Sample Magnetometer measures the magnetic moment of a sample by vibrating it in a relatively uniform magnetic field. The moving sample produces an AC signal proportional to its magnetic moment which is detected and analyzed by the instrument's electronic system. The Magnetometer can be used with any conventional laboratory electromagnet, or can be readily adapted to superconducting magnets.

A wide range of magnetic moments can be precisely measured over an extended range of temperature, field and crystallographic orientation. Permanent and/or induced magnetic moments can be measured and the orientation of



the magnetic moment vector can be determined for any direction in space.

\*Manufactured exclusively by PAR under license in U. S. Patent No. 2,946,948.

### SPECIFICATIONS IN BRIEF

**Differential Sensitivity:** Will detect change in magnetic moment of  $5 \times 10^{-5}$  emu (corresponding to change in magnetic susceptibility of  $5 \times 10^{-9}$  emu) for a 1 c.c. sample in a  $10^4$  gauss field.

**Stability:** Stability of output signal better than 1 part in  $10^4$ /day for fixed coil geometry.

**Absolute Accuracy:** Better than 2%.

**Price:** \$12,500. Model FM-1D with automatic balancing, digital readout \$14,250.

## Sales Offices

**Albuquerque**  
F. Y. Gates Company, Inc.  
2631 Texas, N. E.  
Albuquerque, N. M. 87110  
Tel: (505) 298-1875

**Boston**  
American Dynamics Corp.  
17 Dunster Street  
Cambridge, Mass. 02138  
Tel: (617) 491-6800

**Charlotte**  
Technical Associates, Inc.  
3809 Weona Avenue  
Charlotte, N. C. 28209  
Tel: (704) 523-9121

**Chicago**  
Bard Associates, Inc.  
LaGrange Industrial Park  
LaGrange, Illinois 60526  
Tel: (312) 354-0660

**Cleveland**  
Tiby Company  
2245 Warrensville Center Rd.  
Cleveland, Ohio 44118  
Tel: (216) 371-5335

**Dallas**  
Kemco, Inc.  
P.O. Box 998  
Irving, Texas 75061  
Tel: (214) 253-6740

**Dayton**  
Tiby Company  
1954 North Main Street  
Dayton, Ohio 45405  
Tel: (513) 277-3822

**Denver**  
F. Y. Gates Company, Inc.  
3422 South Bannock Street  
Englewood, Colorado 80110  
Tel: (303) 761-0591

**Detroit**  
Tiby Company  
8701 Fennell Avenue  
Detroit, Michigan 48238  
Tel: (313) 834-9211

**Houston**  
Kemco, Inc.  
6440 Hillcroft St.  
Suite 409  
Houston, Texas 77036  
Tel: (713) 771-1291

**Huntsville**  
Technical Associates, Inc.  
P.O. Box 1443  
Huntsville, Alabama 35800  
Tel: (205) 881-8494

**Indianapolis**  
Bard Associates, Inc.  
6806 North Farmleigh Drive  
Indianapolis, Indiana 46220  
Tel: (317) 849-2723

**Los Angeles**  
O'Halloran Associates  
10700 Ventura Boulevard  
North Hollywood, Cal. 91604  
Tel: (213) 877-0173

**Minneapolis**  
Bard Associates, Inc.  
7700 Morgan Avenue South  
Minneapolis, Minn. 55423  
Tel: (612) 866-1700

**Montreal**  
Ahearn & Soper, Ltd.  
3300 Cavendish Blvd.  
Suite 220  
Montreal 28, Quebec  
Tel: (514) 482-9750

**Orlando**  
Technical Associates, Inc.  
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Orlando, Florida 32803  
Tel: (305) 424-5681

**Salt Lake City**  
F. Y. Gates Company, Inc.  
455 East Fourth Street  
Suite 311  
Salt Lake City, Utah 84111  
Tel: (801) 359-1101

**San Francisco**  
O'Halloran Associates  
3921 East Bayshore Drive  
Palo Alto, Cal. 94303  
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**Seattle**  
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844 Caledonia Road  
Toronto 19, Ontario  
Tel: (416) 789-4325

**Washington, D.C.**  
F. R. Jodon, Inc.  
4922 St. Elmo Avenue  
Bethesda, Maryland 20014  
Tel: (301) 652-5110

**Wichita**  
Kemco, Inc.  
6115 East 13th Street  
Wichita, Kansas 67208  
Tel: (316) 684-8224

**Export (Europe)**  
Thomson Electric Company, Inc.  
50 Rockefeller Plaza  
Room 916  
New York, New York 10020  
Tel: (212) 245-0444

**Export (except Europe)**  
Henley & Company  
202 East 44th Street  
New York, New York 10017  
Tel: (212) 986-5544

## Foreign Representatives

**Argentina**  
Cosin S.A.  
Virrey Del Pina 4071  
Buenos Aires  
Tel: 52-3185

**Australia**  
Technico Electronics Pty. Ltd.  
556 Elizabeth Street  
Melbourne, Australia  
Tel: 34-3694

**Belgium**  
Thomson Belge Sprl  
196A Avenue Louise  
Brussels 5  
Tel: 49-29-54

**Brazil**  
Digimatic Ltd.  
P.O. Box 19027  
Sao Paulo 15

**Denmark**  
Christian F. Rosing Ltd.  
51, Rodovrevej  
Rodovre  
Copenhagen  
Tel: (01) 41-01-11

**England**  
Kelvin Electronics Co.  
Kelvin House  
Wembley Park Drive  
Wembley, Middlesex  
Tel: Wembley 8888

**Finland**  
Havulinna Oy  
Vuorikatu 16  
P.O. Box 10468  
Helsinki 10,  
Tel: 61451

**France**  
Jiveco Electronics  
21 Avenue Victor Hugo  
Paris 16  
Tel: 704-25-20

**West Germany**  
Nucletron Vertriebs GmbH  
8 Munich 54  
Gaertnerstrasse 60  
Tel: (0811) 546081

**India**  
Bali International Agencies,  
Ltd.  
P.O. Box 1676  
Bombay 1, India  
Tel: 264592

**Israel**  
Racom Electronics Co., Ltd.  
74 Nordau Blvd.  
Tel Aviv, Israel  
Tel: 443244

**Italy**  
Eurellettronica  
Milano  
Piazza S. Babila, 5  
Tel: 799-088

**Japan**  
Rikei Trading Co., Ltd.  
Kozato Kaikan Building  
No. 18-14 Nishishimbashi  
1-Chome Minato-Ku  
Tokyo, Japan  
Tel: (591) 5246

**Netherlands**  
Nenimij NV  
74 Laan Copes van  
Cattenburch  
Den Haag  
Tel: (070) 630977

**New Zealand**  
AWA (New Zealand) Ltd.  
Commercial House  
125 Wakefield Street  
P.O. Box 830  
Wellington, C1, New Zealand  
Tel: 43-191

**South Africa**  
Electronic Research Labs.  
Pty Ltd.  
P.O. Box 10523  
Johannesburg, South Africa  
Tel: 23-1705

**Sweden**  
Telare AB  
Box 49025  
Stockholm 49,  
Tel: 248830

**Switzerland**  
Resistronic AG  
Hugistrasse 3  
2500 Biel  
Tel: 032 356 66

**Taiwan**  
Industrial Electronics, Ltd.  
89-2 Lane 75  
Nanking East Road  
4th Section  
Taipei  
Tel: 22423